

Social ecology and group cohesion in pilot whales and their responses to playback of anthropogenic and natural sounds

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LONG-TERM GOALS

This project investigates the social ecology and cohesion of long-finned pilot whales as part of a broad multi-investigator research program that seeks to understand how cetaceans are affected by mid-frequency sonar and other sources of anthropogenic noise. The study of how noise affects large delphinids such as pilot whales is important since these species have different social systems and seem to respond differently to anthropogenic noise sources such as sonar (Curé et al., 2012) compared to beaked whales (DeRuiter et al., 2013; Tyack et al., 2011). However, the baseline behavior of pelagic delphinids is much less well understood compared to beaked whales, making both design and interpretation of controlled exposure experiments difficult (Miller et al., 2012). For gregarious species relying on social strategies to defend against potential predators or competitors, the size, composition and cohesion of the natal group as well as the dive activity of group members likely plays an important role in shaping the decision processes of individuals and to determine the degree of response to a potential threat. Our goal here is to study the social dynamics and effects of noise on group-living delphinids. We aim to gather data to design, conduct and interpret controlled exposure experiments to social delphinids such as pilot whales, with the ultimate goal of understanding responses to naval sonar and improving Navy environmental analyses.

OBJECTIVES

The specific objectives of this research project are to:

- a) collect additional baseline data on pilot whale behavior in a social context, by simultaneously tagging multiple individuals within the same group to study social coordination and group cohesion and how these social dynamics might influence responses to anthropogenic sounds.
- b) to tag individuals across field seasons to study stability of bonds and stereotypy of calls.
- c) to quantify surface group cohesion, speed and orientation of social animals using stereo photogrammetric geocoding in combination with tag data.
- d) to perform sound playbacks to a subset of tagged animals to evaluate behavioral response patterns.
- e) to evaluate the feasibility of estimating dose:response functions for untagged animals.

APPROACH

This project is a continuation of a long-term tagging project investigating the resident population of long-finned pilot whales in the Strait of Gibraltar. Specifically, this grant supports a 1-month field expedition with project participants from Woods Hole Oceanographic Institution, St. Andrews University, and the non-profit research organization CIRCE (www.circe.info). The research team will be based out of the Port of Tarifa and the nearby Port of Algeciras. The aim of this research expedition is to instrument multiple close associates within the same social group with sound and movement recording DTAGs (Johnson and Tyack, 2003). These tags sample a pair of hydrophones, a depth sensor, and a 3-axis accelerometer and magnetometer. Following successful tagging, we will track animals visually and using radio beacons on tags while collecting focal-follow data. When conditions allow, we will perform controlled playback experiments of natural and anthropogenic signals to tagged animals when the group is in a travelling mode at the surface. During these experiments, we will quantify surface responses from a smaller follow boat using a stereo camera system that quantifies the position and orientation of individuals and which allows for quantifying surface cohesion over time.

WORK COMPLETED

The original project was scheduled to take place through the summer of 2014, but was subsequently rescheduled to 2015. This work was recently completed during a 30-day field season in the Strait of Gibraltar between September 1st and September 30th, 2015. Fieldwork was conducted by the PIs in collaboration with CIRCE and relied on the research vessel and local population knowledge of CIRCE for logistics and for identifying animals for tagging.

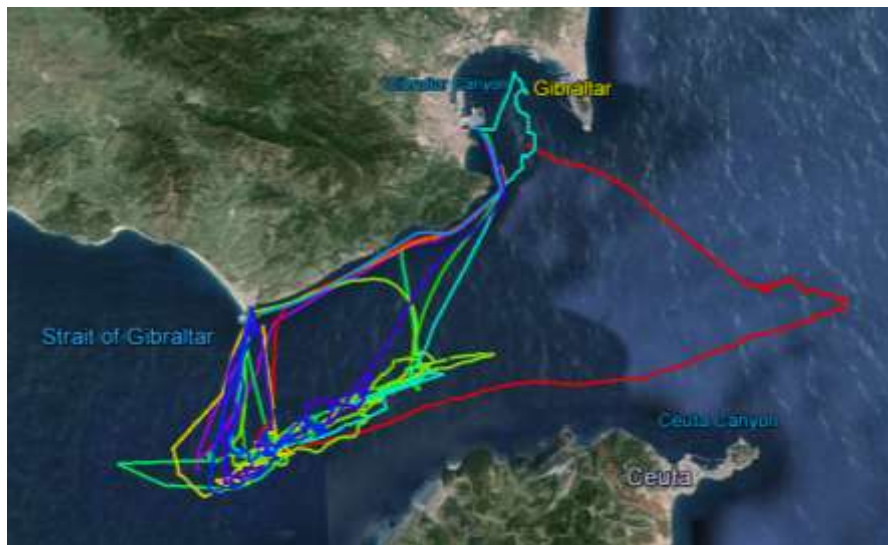


Figure 1: Survey lines from 11 field days in the Strait of Gibraltar during the recently completed tagging expedition that yielded a total of 21 DTAG deployments

During the recently completed fieldwork, we managed to tag 21 long-finned pilot whales across 11 field days, collecting a total of 88 hours of tag data (Table 1). The tagged animals included multiple highly interesting social groups; on two days, we managed to get four simultaneously tagged animals in the same social group instrumented, whereas on a third day, we instrumented a group of 3 animals. Almost all tagged animals were resident animals that inhabit the Strait of Gibraltar all year and are well-known by CIRCE, whereas the group of 3 simultaneously tagged animals were immigrants that

visit the Strait during summer time. All tagged animals were identified using the long-term photo ID database maintained by CIRCE (de Stephanis et al., 2008; Verborgh et al., 2009).

Table 1: Summary of DTAG deployments during September 2015 tagging expedition to the Strait of Gibraltar, Spain.

Tarifa 2015 September Cruise summary

Date	Dataset	Tag-on time	Time on (hours)	Reason for Release
5th	gm15_248a	11:00	8.6637	Programmed
5th	gm15_248b	11:48	7.7906	Programmed
11th	gm15_254a	10:48	0.2426	Breach
11th	gm15_254b	11:31	3.0072	Foraging dive
11th	gm15_254c	12:34	0.4056	Breach
11th	gm15_254d	12:47	4.6804	Fast swim
14th	gm15_257a	10:24	0.3945	Fast swim
14th	gm15_257b	10:30	0.5110	Fast swim
14th	gm15_257c	10:54	0.1810	Fast swim
14th	gm15_257d	10:59	0.0016	Fast swim

Date	Dataset	Tag-on time	Time on (hours)	Reason for Release
14th	gm15_257e	13:30	4.2797	Foraging dive
14th	gm15_257f	14:16	5.2164	Programmed
14th	gm15_257g	15:20	6.2645	Programmed
14th	gm15_257h	15:30	3.8665	Programmed
17th	gm15_260a	14:30	0.1758	Breached off
18th	gm15_261a	09:14	4.8097	Programmed
18th	gm15_261b	09:57	3.8400	Programmed
22nd	gm15_265a	12:17	9.5638	Programmed
22nd	gm15_265b	12:19	2.4648	Foraging dive
22nd	gm15_265c	12:20	8.7537	Foraging dive
22nd	gm15_265d	15:17	6.5008	Programmed
23rd	gm15_266a	14:14	7.0954	Programmed

Our sighting rate during this expedition was remarkably high. We found animals on almost all good weather days, and resighted the same social groups across most of these days. On multiple occasions, we managed to tag previously tagged animals, though instrumenting complete social groups with tags across multiple years has not been possible yet. During the field period, we managed to conduct playbacks of killer whale, unfamiliar and familiar pilot whale calls to a group of 3 simultaneously tagged animals. Playbacks were conducted at relatively short range (50-100m distance) and at realistic sound exposure levels (RL 114-120 dB re 1 μ Pa rms as measured on receiving tags). While weather prevented more exposures for this field season, the short exposure period we have converged on for this project was a great advantage for operating in the high-current conditions of the Strait of Gibraltar. While these exposures are still to be analyzed, they will contribute towards our understanding of the signaling mechanisms of these animals and towards understanding how they respond to natural and anthropogenic signals in their environment.

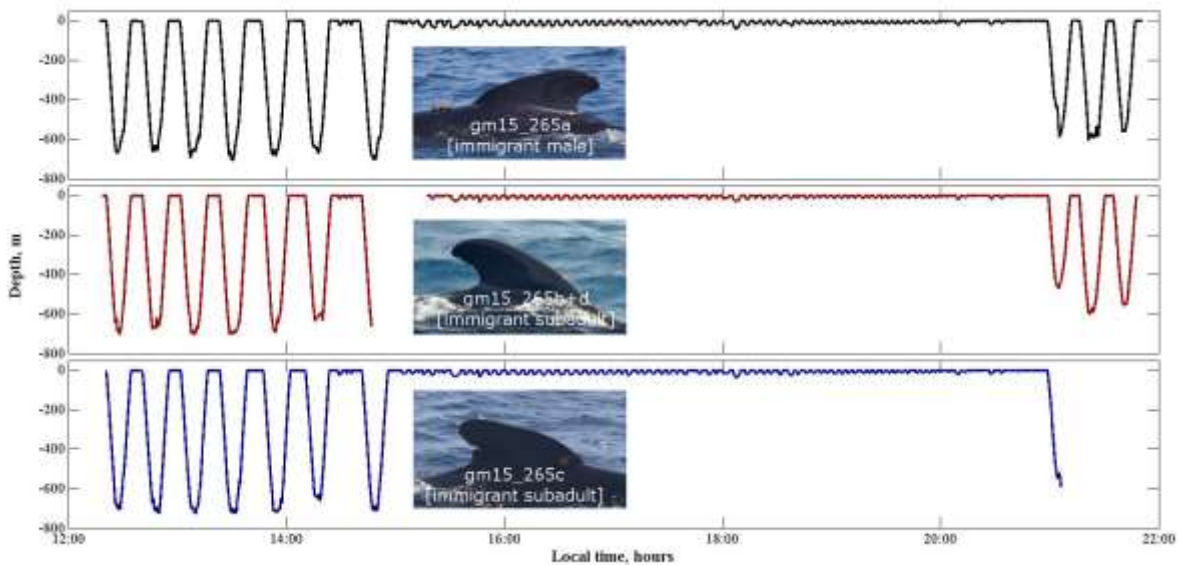


Figure 2: Group of 3 simultaneously tagged immigrant pilot whales from September 2015, demonstrating the highly synchronous foraging behavior of these animals.

RESULTS

As fieldwork has just been completed, there are few significant results related to this field season yet. Multiple highly interesting datasets were collected, and preliminary inspection of data supports our previous observations that these animals coordinate a large fraction of their deep foraging dives (e.g. figure 1). The advantage of having all group members tagged during these periods is that it allows us to obtain highly precise temporal synchronization and to track the distance between animals when they are echolocating. This is the basis for two papers under preparation: in one of these papers, we investigate the spatial coordination of foraging pilot whales to identify the behavioral decision rules behind collective foraging in long-finned pilot whales; In another paper, we employ informed agent based models to quantify the influence of different foraging strategies and individual decision rules on individual and collective foraging success, to understand the ecological importance of different collective foraging strategies.

At the same time, having all members of a social group tagged provides us with a unique perspective into social communication by allowing us to reliably identify acoustic vocalizations from each tagged individual. This provides us with more accurate estimates of individual and group vocal rates during different behavioral states, which is of importance for passive acoustic monitoring. These data will also be essential for evaluating if we can reliably use call rates, or production of specific call types or signal categories such as stress or excitement calls, as response criteria for playbacks to untagged animals.

IMPACT/APPLICATIONS

The proposed research is part of a broad multi-investigator research program that seeks to compare responses of beaked whales and other odontocetes to playbacks of mid-frequency sonar sounds vs other anthropogenic signals. These projects aim to define exposure:response functions for risk to beaked and other whale species for exposure to naval sonars, and to suggest improvements for

mitigation. The potential impacts and causal mechanisms behind these are becoming increasingly well known in the case of beaked whales (Moretti et al., 2014; Tyack et al., 2011). Strandings of pilot whales have been reported during naval sonar exercises (Hohn et al., 2006) and while these incidents provide only weak evidence for a link between sound exposure and stranding, they suggest the need to investigate the potential impacts on delphinids. Our study here seeks to understand the baseline behaviour of pilot whales in a social context that relies upon repeated work with the same individuals, which can only be completed in this field site. Our proposed project will provide essential data for how to structure playbacks and analysis for current and future playback studies. This project will provide information on the typical responses to biologically relevant (killer whale and conspecific) and anthropogenic sound stimuli that will be analysed in a collaborative effort with other research groups with similar playback protocols. Our simultaneous tagging approach is also the only current method for estimating accurate individual and group vocal rates for social odontocetes, and the only way of understanding the influence of sociality on diving behaviour and reaction to disturbances.

RELATED PROJECTS

P. L. Tyack and A. Bocconcelli: Tagging and Playback studies of toothed whales (N000140910528) preceded this project with previous work on long-finned pilot whales in the Alboran Sea.

P. L. Tyack and A. Bocconcelli: Baseline behavior of pilot whales and their responses to playback of anthropogenic and natural sounds (N000141410417) preceded this project with the first tagging expeditions to study long-finned pilot whales in the Strait of Gibraltar.

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